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Alissa Peitscher
Iowa State University

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AGRICULTURIST
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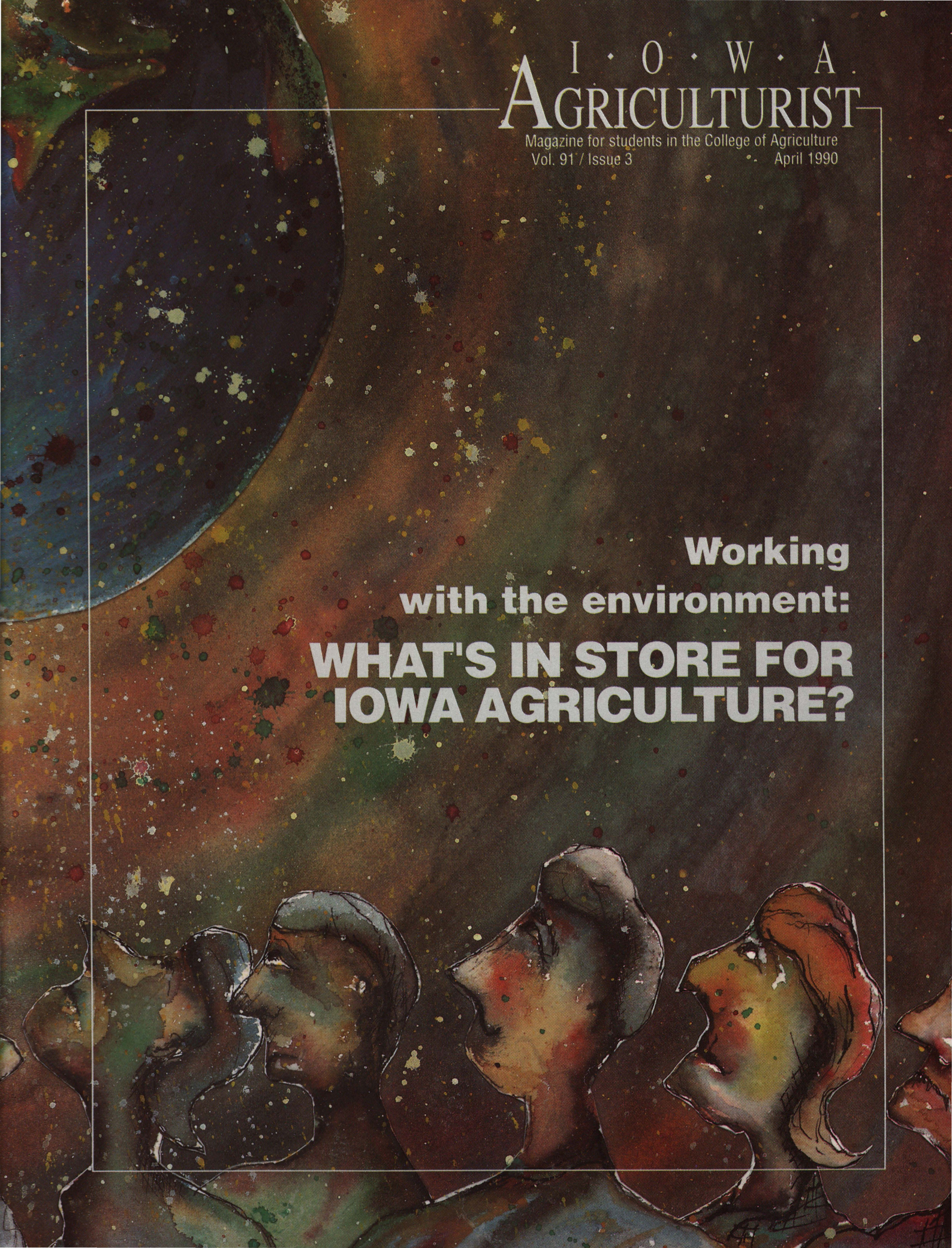
Working with the environment:

WHAT'S IN STORE FOR IOWA AGRICULTURE?



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SPECIAL REPORT:
LIVING WITH SUSTAINABLE AGRICULTURE

FEATURES

DEPARTMENTS

WELCOME TO THE 90S:

Decade of the environment

Environmentalism surrounds us. Grocery stores offer a choice of plastic or paper sacks, some even offer a rebate for bringing your own. The words "degradable" and "recycled" can be found on everything from disposable diapers to greeting cards.

That concern for the environment has permeated every aspect of agriculture as well. From calls to change tillage systems in hopes of controlling soil erosion, to pleas for reduced fertilizer and pesticide use to save our groundwater, people both inside and outside of agriculture are becoming concerned about the way we produce grain and livestock.

Experts at the 1990 Agribusiness Outlook and Policy Conference held in Des Moines last February agreed that the 1990 Farm Bill is receiving significant attention from non-farm interests.

The experts are calling for agriculture to take an active role in creating legislation to protect our environment before someone else writes the rules for us.

Some non-farm interests feel that people in agriculture are ignorant and apathetic on environmental issues. Is that true of ag students at ISU, the farmers and agribusiness persons of tomorrow?

Earth Week, April 16-22 offers an opportunity to learn more about and show concern for the delicate balance between agriculture and the environment. Wednesday, April 18, has been dubbed Agriculture Day and features a panel on farm chemicals, demonstrations on groundwater flow, and alternative farming methods.

All are important for us to understand as we move through the 1990's: the decade of the environment.

Thanks for reading.

Alissa Peitscher

Alissa Peitscher

"It's time to step back and take a look at our world." Cover Illustration by Nancy Lehet

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Current trends are away from intensive row cropping and toward preserving the environment for all species.

RETURN OF THE WETLANDS

After years of declining wetland habitat and the dominance of corn and soybeans on Iowa's landscape, wetlands are reappearing.

By Jeff Dankert

Iowa has lost 98 percent of its wetlands because of agriculture. But now, after years of diminishing wetland habitat and the dominance of corn and soybeans on Iowa's landscape, wetlands are reappearing. In fact, wetlands were not completely exterminated but lay dormant between the rows of crops, awaiting the return of life-giving water.

The key element for the return of wetlands is called the seed bank. The seeds of wetland plants such as cattails and bulrushes can remain viable in soils even after the land's conversion to row crops. These seeds lie dormant in the soil and make up the "bank" from which a wetland can be re-introduced simply by plugging drainage tiles and allowing rain to fill the shallow basin.

A study conducted by Carol Wienhold and A.G. van der Valk, both of the ISU botany department, investigated the number of wetland seeds remaining in the seed bank. They sampled farm fields that had been drained from five to 70 years ago and found that after 20 years the seed

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bank lost about 60 percent of its wetland plant species. Wienhold and van der Valk concluded that restoration projects should focus on cropland that was drained less than 20 years ago.

ISU postdoctoral student Beth Middleton has been working on locating potential sites for wetland restoration, funded through the Leopold Center for Sustainable Agriculture at ISU. "Seeds have always been important in prairie glacial wetlands," says Middleton.

Some seeds, however, are not as tolerant to agriculture as others. "The seeds only last so long," says Middleton. "Some of the species are maintained for a very long time and other species are lost almost immediately. Cattails will come back right away because the seeds blow in on the wind."

Sue Galatowitsch, also a graduate student in ISU's botany department, is studying the selection of sites for restoration and their success.

"I think in a lot of cases they're [restoration workers] relying not only on seed banks, but on what was in the weed flora," says Galatowitsch.

She says that in many cases the drainage of the land is incomplete, and wetland plants get periodic chances at regeneration during wet years. Galatowitsch says that she's seen wetland plants that farmers would classify as weeds growing between rows of corn. This growth can be enough to renew the seed bank or contribute to the new life of a restored wetland. She says that of all agricultural uses of the land, pastures offer the most potential for restoration because they contain the richest seed banks. But most drained wetlands are used for growing crops, not for grazing cattle. Galatowitsch also says that most wetlands occur on fields that support corn because soybeans cannot tolerate wet, lowland soils.

During last November's Institute of World Affairs symposium on global ecology, ISU botany department professor Bill Crumpton said, "It's not just that we've converted prairies and wetlands into corn; we have modified the basic hydrology and the way that water and materials move through the soil."

We have modified the basic hydrology and theway that water and materials move through the soil.

Crumpton says that Story County was "settled very late because it was so flat and so wet. Story County was largely wetlands, and you could not walk a mile in one direction without running into a wetland."

Galatowitsch says that records show that people in Wright County ran flatboats in and out of Clarion for supplies during the spring, an indication of what some areas were like before drainage.

Figures from the Iowa Natural Heritage Foundation show that in the early 1800s there were 4 million acres of wetland habitat in Iowa. By the turn of the century this amount had decreased to about 1 million acres. By 1922, 368,000 acres existed, and by 1950 only 50,000 acres remained. Today, about 30,000 acres of wetlands remain in Iowa, a small remnant of a once-great breeding ground for waterfowl.

Waterfowl populations have been on the decline because of the loss of wetland habitat for nesting. The subsequent decrease of nestlings is directly attributable to intensive agriculture. The U.S. Fish and Wildlife Service found that in 1985 waterfowl species including mallards, pintails, blue-winged teal, black ducks, redheads and canvasbacks reached all-time lows. Now these bird populations have a good chance of recovering.

Organized efforts are underway to restore wetlands where agriculture has eliminated them. One of these efforts is the North American Waterfowl Management Program initiated in 1986. This program is a cooperative effort by the governments of the United States and Canada, signed by the Canadian Minister of the Environment, Tom McMillan, and the U.S. Secretary of the Interior, Donald Hodel. The $1.5 billion plan has the goal of increasing the average fall migration of birds in North America to 100 million by the year 2000 and to maintain an average breeding population of 62 million birds.

Wetland value cannot be solely measured in numbers of ducks. Over 350 species of wildlife use the wetlands that remain in Iowa, including muskrats, marsh wrens, yellow-headed blackbirds and terns. A recent restoration along the Cedar River in Linn County near Palo, the 369-acre Chain-O-Lakes, helped to preserve several rare

plants such as cleft phlox, black holly, ledge spike moss, kitten tails and purple cross. It also protected one of the last strongholds of the endangered blue-spotted salamander.

Wetlands also act as water-purification and flood-control systems. The water that leaves a wetland is cleaner and less polluted than the water entering the wetland. The aquatic plants in a wetland act as a link between the atmosphere and the bacteria in the soil. When provided with oxygen from the atmosphere, these bacteria can break down excess loads of fertilizers and pesticides, cleaning the water naturally.

Wetlands also act to buffer the effects of a drought, gradually releasing water that has been gained during the rainy season to replenish groundwater supplies. This function of wetlands could help to cure the current problems Iowa has with groundwater pollution and drought-stricken water supplies.

Wetlands also act as soil traps, slowing the flow of water runoff and preventing the loss of soil.

The restoration of wetlands largely depends on landowners' willingness to sell property. Some of the land can be set aside under the Conservation Reserve Program (CRP). The CRP pays farmers to set aside land for wildlife habitat and soil conservation. The 1982 Natural Conservation and Wildlife Area Tax Exemption Program, or "Slough Bill," also gives an economic incentive to farmers for turning land with row crops into naturally vegetated areas.

"The vast majority of restorations are occurring on private lands, or CRP lands," says Galatowitsch.

"There are people who are skeptical but willing to give it a try," she adds. "They've been sort of talked into it a bit. They consider it experimental. They're taking a wait-and-see attitude.

She also says that the restoration of wetlands "seems to be coupled with an overall plan on their farm to reduce soil erosion.

"I've seen numerous situations where you have a farmer nearing retirement and he's interested in getting out of farming but he's not interested in moving off of his land," Galatowitsch says. "I've seen people put all but their homestead in CRP, and then restore any wetlands on their land, and those people get an alternative use of their property during retirement. As long as the subsidies hold out, it seems as if it might be a somewhat reliable retirement income.

"There are other people who are still active producers and it's clear that they want to give a segment of the land over to some other use," Galatowitsch says.

The success of wetland restoration rests entirely on the cooperation of farmers. For Iowa to meet its goal of creating an additional 30,000 acres by the year 2000, Iowa farmers will have to make a sacrifice if new conservation legislation doesn't renew the subsidies paid out to them. The current CRP program was created out of the 1985 Farm Bill and runs until 1995.

Galatowitsch says that if new subsidy programs are not created beyond the tenure

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30,000 Iowa acres to be restored

A project called the Prairie Pothole Joint Venture is a cooperative effort between the Canadian provinces of Alberta, Saskatchewan, and Manitoba and the states of Montana, North Dakota, South Dakota, Minnesota and Iowa. The program will protect and restore 1.1 million acres of wetlands in North America by the year 2000.

Iowa's share of this plan involves the purchase of 30,000 acres in Iowa for wetland restoration, most of which is privately owned farmland. This project will cost the state about $1.8 million a year, with $1 million coming from the sale of duck stamps to hunters. The project also depends on generous contributions from organizations such as Ducks Unlimited and the Sierra Club, along with legislative funding of approximately $500,000 a year, requested by the Iowa Department of Natural Resources.

The prime waterfowl habitat in North America lies in the prairie pothole region, which stretches from Alberta, Canada, to Des Moines. This land was rich in upland prairies and shallow lakes and marshes, created by the glaciers that scoured this continent. It is this region in which large-scale agriculture is practiced and in which Iowa must share the responsibility of restoring wetlands. The southern tip of the region occupies the northwestern 35 counties of Iowa.

"We've lost the southern part of the prairie pothole region, and this is a big chance to get that chunk of breeding ground back," says Galatowitsch. Her study area consists of land in southeastern South Dakota and southern Minnesota and the 35-county region in Iowa.

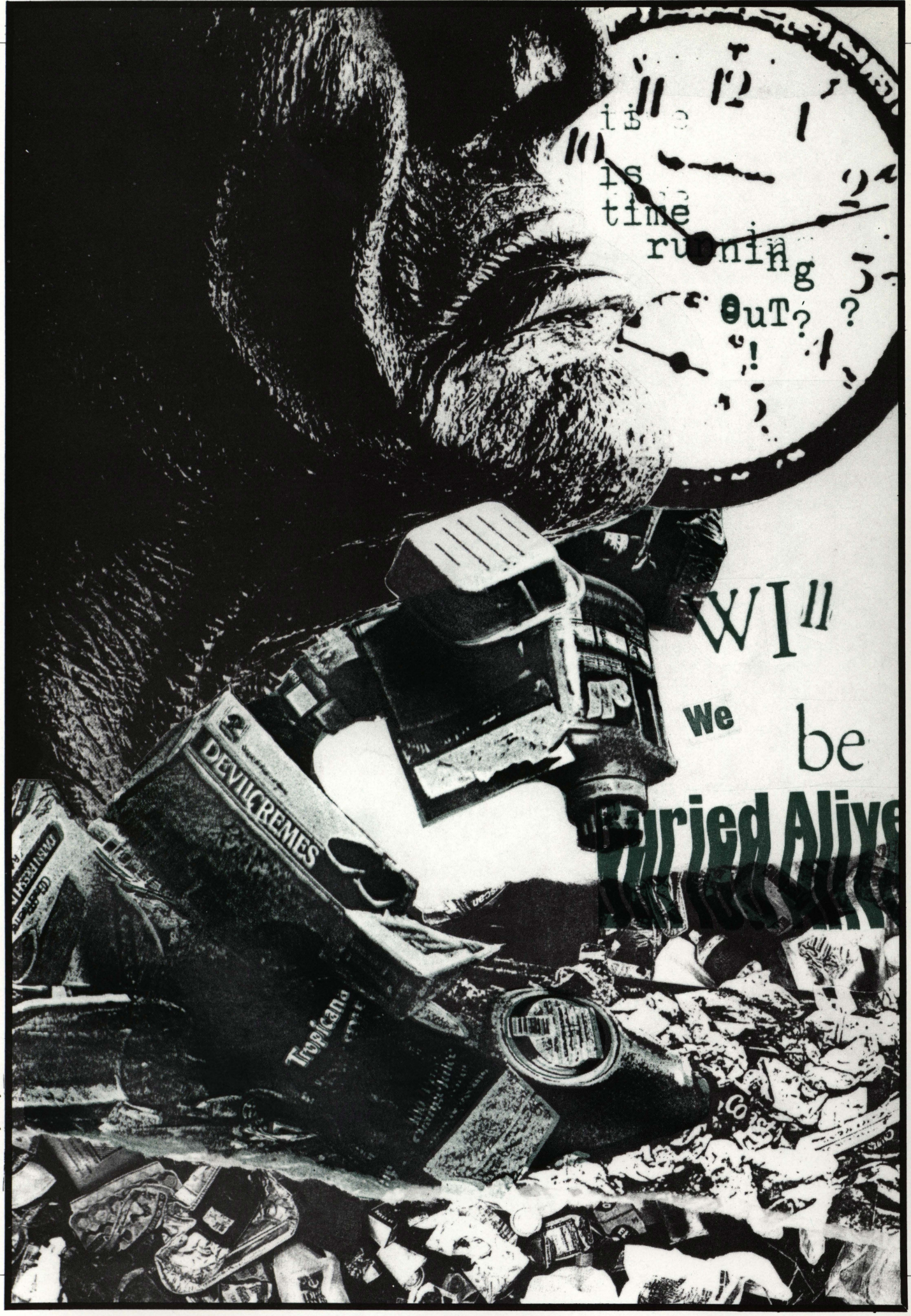

Illustration by Nancy Lehet

SOLVING *the* PLASTIC DILEMMA

By Alissa Peitscher

Unless we stop using plastic grocery bags, milk jugs and Big Mac® containers, Iowa, like the rest of the United States, will face a serious trash disposal problem within 20 years.

The Iowa Department of Natural Resources expects all but 20 percent of Iowa's municipal solid-waste landfills to be full by 2010.

But if successful, the work of six Iowa State researchers will break down part of the solid waste problem and create a new market for corn.

The Center for Crops Utilization Research (CCUR) at ISU, headed by Dr. Larry Johnson, professor of food technology, is a six-person team that studies degradable plastic from manufacture to disposal. Three members of the group, Jay-Lin Jane, assistant professor of food technology; Alan Schwabacher, assistant professor of chemistry, and Robert Gelina, associate professor of industrial education, are studying what Jane describes as the material composition part of the research.

Plastic has wrapped itself around every area of life. Waste disposal problems in the United States have increased concern for a more easily degraded product. Six ISU researchers are looking for an answer to the degradable plastic problem using Iowa's strongest weapon—corn.

"We're studying different ways to make plastic more easily degraded, or broken down," says Jane.

Three other researchers, Zivko Nikolov, assistant professor of food technology; Tony Pometto, assistant professor of food technology, and Joel Coats, professor of entomology, are studying how plastic degrades, the micro-organisms that degrade plastic and how soil conditions affect the rate of plastic degradation.

The CCUR received $398,000 from the Iowa Legislature and $150,000 from the Iowa Corn Promotion Board for the five-year project. Last May the CCUR received a $100,000 grant from the U.S. Department of Agriculture

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and $150,000 from the Legislature for plastic-making and testing equipment.

"I originally became interested in this project because of the environmental significance that it holds. I also think it's important to develop new markets for Iowa products," says Jane.

Jane describes herself as a carbohydrate chemist, which means that she studies starch and related compounds and explores their basic properties and uses.

Plastic is traditionally made from polyethylene, a compound derived from petroleum. With limited oil supplies in the world, Jane's research could make the availability and price of plastic less dependent on global conditions. It will also yield a product that breaks down more easily, reducing the amount of plastic waste in landfills. The U.S. Environmental Protection Agency estimates that more than 10 million tons of plastic entered landfills in 1986.

Starch molecules are polymers, long chains composed of hundreds or thousands of smaller molecules of varying sizes. The focus of Jane's research is to make corn starch, a large, hydrophilic, or "water-loving," polymer, more compatible with polyethylene, a smaller, hydrophobic, or "water-hating," polymer.

Jane describes the difference between the way the polymers react with water. "When you cook starch in water, you get a paste. The starch bonds with water because it is hydrophilic. But polyethylene will not dissolve in water because it is hydrophobic."

The efforts of Jane and her coworkers at Iowa State have led to three patents related to biodegradable plastic technology. One patent is for using a modified starch, called octenylsucciate (ak-ten-eel-suk-see-ate), which is more compatible with polyethylene than unmodified starch.

"Octenylsucciate starch is commercially available. It is used to stabilize oil, such as that in salad dressing. What we have patented is a way to use octenylsucciate to act as a bridge between starch and polyethylene," says Jane.

"I originally became interested in this project because of the environmental significance that it holds. I also think it's important to develop new markets for Iowa products."

A second patent is for a small-particle starch. Jane could not divulge the name of this substance because the patent application process has not been completed. Researchers created the small-particle starch by treating corn starch with a mild acid, which loosens the starch structure, and then grinding the substance.

"Through this process, we create a starch that is one-half to one-eighth the size of untreated corn starch. A smaller starch particle size can reduce the discontinuities, or weak spots, of thin plastic film," says Jane.

Small starch particles allow for a thinner film, which reduces the amount of polyethylene needed and makes the starch more compatible with polyethylene. Smaller starch particles also minimize the loss of tensile strength, or a compound's ability to resist being pulled apart, that is often associated with starch-polyethylene blends.

Jane says that rice starch is smaller than corn starch, making it more compatible with polyethylene, but that the high price of rice starch limits its use in biodegradable plastics.

The group has also patented a modified polyethylene that can substitute for polyethylene and can act as a bridge between molecules, leading to increased tensile strength.

Jane says that although plastic products containing starch exist, her work is geared toward modifying corn starch to make it more compatible with the petroleum-derived polyethylene. The modified starch bonds with polyethylene molecules, but because starch is a biopolymer, a polymer derived from an organic source, it is more easily degraded by microorganisms.

Although the main goal of this project is to improve current technology, Jane and her coworkers have had limited success in increasing the level of starch in plastic without sacrificing quality.

Jane's research efforts have produced plastic that is 50 percent modified starch, but the final product has a lower tensile strength than its pure polyethylene counterpart. Jane said that although this compound cannot be used for grocery sacks, which require higher tensile strengths, the high-starch content film is well-suited as an agricultural mulch, an application where high degradability is desirable and tensile strength is less impor-

tant.

Modifying corn starch by reducing the size of the polymer makes it more compatible with plastic, but does not affect its degradability.

Jane says that starch, in the presence of oxygen and a catalyst, is easily and completely degraded by micro-organisms.

When the starch is exposed to air and metals, such as would exist in a landfill, the metals act as a catalyst in the breakdown of plastic, which further accelerates the process. When starch is degraded, it increases the surface area of the plastic, making the polyethylene more susceptible to degradation.

The introduction of starch into polyethylene also aids degradation by disturbing its crystalline structure, making the polyethylene more susceptible to the effects of microorganisms.

"In its crystalline form, polyethylene is a tough structure, virtually impenetrable to microorganisms. But once it is broken down to a molecular size, microorganisms can digest it and use it as energy," says Jane.

Jane says that some commercial products, which typically contain 6 percent starch, enhance the degradation process by including a pro-oxidant. "A pro-oxidant is a substance that can easily react with air to be oxidized and release a single electron, called a free radical. That free radical provides the energy to start depolymerization, or the breakdown of a polymer into its component pieces," Jane says.

Although not currently being studied by the group, photodegradable plastic, or plastic that degrades in the presence of light, is also being used to reduce the waste problem.

Photodegradable plastic is different from biodegradable plastic, but Jane says that they degrade by a similar mechanism. "Photodegradable plastics contain a certain chemical that generates free radicals when exposed to ultraviolet light. Although it's been widely used, it doesn't work in a landfill situation because buried material is cut off from ultraviolet light, the element needed to start the reaction."

Jane says that the group will continue its work to increase the amount of starch in plastic. "We hope to make modifications until we can develop a plastic that's made entirely of bio-polymers. Also, we hope to expand our work into plastic foams, because we focus on plastic films and solids now. We've come a long way, but the future of this work is virtually limitless," says Jane.

REAP:
Guarding Iowa's
natural resources.

Expanding Environmental Protection

By Denise Roth

Iowa farmers are furthering their involvement in good land stewardship by becoming involved in the Iowa Resource Enhancement and Protection program that was enacted in the 1989 session of the Iowa General Assembly. Farmers aren't the only participants in this program. All areas of agriculture are being affected because the nationwide program is so extensive.

The Resource Enhancement and Protection Act (REAP) changes the emphasis of state soil conservation programs by including programs that assist Iowa farmers in protecting the environment. "The new program will complement existing soil conservation methods and expand the scope of assistance we can provide to our farmers," says Iowa Secretary of Agriculture Dale Cochran.

"The role of the soil and water conservation district will be to assist farmers in the implementation of these practices."

The program calls for each district to establish a program of water quality protection practices, such as reforestation, woodland protection and enhancement, wildlife habitat preservation and enhancement, protection of highly erodible soils and water quality protection, Cochran adds.

"The role of the soil and water conservation districts will be to assist farmers in the implementation of these practices," says Cochran.

Cochran believes that the REAP Act "will greatly expand the [Agriculture] Department's existing conservation programs and challenge soil and water districts to address Iowa's environmental concerns. It is only fitting that the Department play a major role in the protection of our environment as water and soil are the lifeblood of our state's agricultural history."

"The program has been successful in Iowa," says Gerald Miller, Iowa State University Extension Service agronomist. "It was designed to protect highly erodible land by providing permanent vegetative cover, and that's exactly what it's doing. Much of Iowa's steeper land has been taken out of row-crop production."

This federal program gives farmers the opportunity to convert highly erodible

fields into permanent cover for ten years. Most of the land has been planted to grasses and legumes. Only 9,653 acres — one-half of one percent of the total acres — have trees. Another 5,435 acres are devoted to wetlands.

"Farmers have been reluctant to plant trees," Miller explains, "because land planted to grasses and legumes can be more easily converted to tilled cropland in the future, as long as an acceptable conservation plan is in place."

The program has turned out to be expensive for the government. Many farmers have enrolled because farmers who do not develop conservation plans for their highly erodible land risk losing U.S. Department of Agriculture funds such as subsidies and FmHA loans.

Miller foresees revisions in the program in the 1990 Farm Bill. "I anticipate Congress to expect more tree plantings. If it is passed, trees will probably be a new provision."

New tillage practices must be implemented on highly erodible land as well as on land that will be reclaimed ten years after the program was implemented.

"Students need to be involved in what is happening in the industry," Miller notes. "There will be continued modification of machinery to deal with the new tillage practices. Students must also be aware of the government involvement in the program and the impact of these acts and laws on the future of agriculture."

Reduced tillage is one form of tillage that the act implements. Reduced tillage systems also change weed control practices. "The use of preplant herbicides is usually not an option because incorporation of tillage passes destroys crop residues, which are required for erosion control," says Stewart Melvin, ISU Extension agronomist. "Post-emergence herbicides are the best." Non-inverting tillage tools are being implemented as the number of reduced- or no-till systems increases.

"Students must be aware of the government involvement in the program and the impact of these acts and laws on the future of agriculture."

Through involvement in REAP, Iowa farmers can improve their land stewardship and help preserve the productivity of Iowa soil for tomorrow's farmers.

The new bacterium *Bacillus thuringiensis* may be the first piece in solving the environmental puzzle.

By Valerie Larson

Each time Iowa farm wife Verla Larson bites into a piece of yellow sweet corn grown in her family's field, she wonders if all the chemicals have been washed off thoroughly. Are the ears safe to eat? Is the water in which she cooked the ears free of insecticide contamination? She is certainly not alone in her fears.

Families from coast to coast worry about the environmental and health risks associated with insecticides and pesticides. These chemicals are used to poison insects that feast in cabbages, peas, corn, broccoli and numerous other vegetables and fruit brought to the tables of American consumers.

Someday these worries may be diminished because of genetic engineering research conducted by an Iowa State University scientist. If the insecticide is formulated, scores of farmers may use this product to protect themselves and the environment. Groundwater would be less contaminated, animals would be safer and less chemical buildup would affect soils.

Professor Robert Andrews, of the microbiology department, is studying ways of transporting foreign DNA into a bacteria, which would expand the host range of an environmentally safe bacteria used in insecticides.

First discovered on diseased silkworms in Japan in 1902, *Bacillus thuringiensis,* or Bt, is a bacterium that kills specific varieties of insects. When formulated in different insecticides, the bacterium poisons caterpillars, gnats, mosquitoes and beetles.

A major concern about pesticides and insecticides is their effect on the environment. Most

importantly, the Bt insecticide isn't harmful to human beings or animals. Andrews says, "A person can spray it (Bt insecticide) and pick it (corn) the next hour." The product doesn't pose risks to the person applying it or to those living in the area.

The Bt insecticide doesn't build up in the soil or the groundwater because it is a natural product that degrades.

The insecticide may control only a portion of the pests found in a field or garden. For example, *Dipel,* a Bt insecticide, kills the European corn borer on corn, but it doesn't kill the corn earworm.

These insecticides need frequent application. Andrews says it may last only one to two days and this makes it more expensive.

Compared to other insecticides that pose risk to the environment, such as *Counter*, a Bt insecticide may cost a minimum of $6.50 per pound, whereas *Counter* costs $1.58 per pound. For a 200-acre field of corn, Bt costs $11,310 and *Counter* costs $2749.

Although Bt is more expensive than chemical insecticides in use on a per acre basis, Andrews says that Bt has advantages. Andrews said it could be made into a more potent, effective and cheaper insecticide that is comparable to other chemical products, which is what Andrews is studying in his ISU lab. If Bt kills specific insects, he asks, can other bacteria be added that poison other insects?

Bt produces a crystal toxin, which is like a clump of protein, says Andrews. The poison looks like the sugar crystals produced by dried maple syrup. Different subspecies have different shaped toxins.

The Bt insecticide is applied to a plant such as corn through aerial spraying or a wettable powder, which is powder mixed with water before application. The European corn borer eats into the corn stalk and ingests the toxin.

The diamond-shaped protein toxin is "turned on" by the alkaline, or neutralizing, conditions in the insect's gut. How potent the toxin is depends on how many "receptor sites" there are on the wall of the corn borer's gut. A receptor site can best be described as a V-shaped indentation. After ingestion, if the activated toxin attaches to the receptor site, it paralyzes the corn borer. The insect immediately stops feeding.

Within hours the toxin destroys the cells of the gut's wall, and the degraded gut enters the bloodstream, distributing the poison. In one to two days the corn borer dies.

Andrews says the key to understanding this particular bacteria and finding ways to make it more effective and less expensive is through transposons.

Transposons are small fragments of DNA referred to as "hopping genes," says Andrews. They have been known in biology for some time, he says. They can jump from gene to gene or from cell to cell.

Andrews, however, is studying a particular transposon called TN916. This organism, he says, has the ability to pass from one gene to another and generates specific mutations. Through TN916, foreign DNA can be introduced into Bt, enabling it to poison different or more insects. Inserting foreign DNA, for example, is injecting a bacteria strand toxic to the corn earworm into the Bt subspecies that doesn't have the capability to be poisonous to both the corn borer and the corn earworm. After inserting the foreign DNA, the Bt would be toxic to both pests.

However, because the transposon requires cell-to-cell contact to transfer foreign DNA, Andrews sats that there must be some window or portal for transposons to pass through into a cell. He asks, "Are there genes that exist in nature that we can put into the bacteria?"

Andrews says he's doing basic research on Bt. One of his experiments is trying to locate the window. "Transposons are mainly a tool, and my goal is to understand how they hop from one cell to another," he says. He predicts an improved insecticide will be available in the future.

Andrews received $40,000 from the ISU Biotechnology Council and $100,000 from the USDA Competitive Grants Program. He recently received a $160,000 renewal from the USDA.

If one application of Bt insecticides can be used, Andrews thinks that the product will grow in popularity. A less expensive insecticide appeals to more farmers, he explains, and so the cost will have to come down.

There are laws that require a person to get a license to apply chemicals because of environmental concerns such as groundwater contamination and health risks such as cancer. By July 1, 1990, every insecticide will be considered as "restricted use" and licenses will be required to buy them.

Iowa Secretary of Agriculture Dale Cochran scheduled a meeting on March 1 to re-examine Iowa's policies on the use of the chemicals atrazine, alachlar and nitrogen fertilizers. Recent studies of wells in Iowa show "widespread low levels of pesticide contamination and widespread nitrate contamination at levels of immediate concern," says George Halburg, state geologist.

Andrews says, "It's critical to find alternative methods for insecticides because of the en-

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"It's critical to find alternative methods for insecticides because of the environmental concerns."

vironmental concerns."

Andrews also proposes to study expanding the numbers of pests Bt insecticides kill and the range of pests. Andrews also hopes to work on a bacterium that would last longer in the environment and to clone a gene that will produce its toxin in the plant.

Andrews, who has worked on Bt since 1974 as a graduate student at Washington State University, says he enjoys what he's doing. He describes his research as detective work and said, "It's sort of like solving a puzzle."

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of CRP the success of the program may rest on how much of the land changes ownership. She says that recently a farm with a restored wetland was sold and the new owner was disappointed to discover that it was under CRP contract. She says the farmer will most likely drain it and put it back into crop production once the contract expires in 1995.

She adds that because of the time limit on CRP, conservationists are trying to establish as many wetlands as possible "before that window runs out."

"Iowa farmers have been very cooperative," Galatowitsch says. "As you go northward into areas where there are still "swamp buster" (subsidies for draining the land) conflicts, where they're still doing wetland drainage, oftentimes I think there is a little bit of a social stigma, or a little bit more of a social conflict about the wetlands issue. That doesn't occur down here because there are no wetlands left. So there are really very few people down here that pit their philosophies against each other."

According to Galatowitsch, there have been 500 restorations per year in her study area since 1987. She says that for every project on public land there may be 50 restorations on private land.

Galatowitsch says that the current interest in groundwater pollution may give wetland restoration even more support in the future. She also adds that a "permanent wetland provision" may be included in the 1990 Farm Bill.

RESTORING DIVERSITY IN IOWA'S FIELDS

By Shane Stratmoen

A cold February sun shines down on a barren field; the grain lies stored safely in a bin. A harsh wind drives across the field, and topsoil billows from the earth like smoke from a wildfire. It is a winter with little snowfall, and the heavily tilled field has no protection from erosion.

Another scene in another field. A corn crop stands limply against the summer sky, not a lush green, but the sickly yellow caused by excess nitrogen in the soil. The year has been dry, with too little rain to fully use the nitrogen fertilizer spread early in the summer.

"One factor that will come into play is that the system is a little more management intensive than the conventional systems."

When the rains come, they will wash excess nitrogen into the earth, endangering the groundwater below.

Is Iowa's agriculture industry destroying the earth even as farmers collect its bounty? Too many traditional agricultural methods pose hazards to the environment, which is why researchers at Iowa State are pioneering methods of sustainable agriculture--agriculture that maintains the economic profitability of farming while preserving the quality of Iowa's land.

Richard Cruse, a professor of agronomy at Iowa State, is developing a method of raising crops that uses techniques familiar to farmers for years, but in ways that substantially lessen damage to the land.

Cruse experiments with a technique called strip intercropping rotation. When using this method, a farmer would plant a strip of corn, perhaps 12 feet wide, and beside it a strip of soybeans, also 12 feet wide, in the same year.

"Instead of one big 400-acre field with only one crop," Cruse says, "you end up with two 200-acre fields broken up into alternating strips." In the next planting season, the farmers reverse the location of the crops.

This technique is a variation of crop rotation, a farming technique used by generations of farmers. They plant and harvest a legume such as soybeans during one year, and then a crop such as corn in the same field the following year. Crop rotation provides time for the soil to replace nutrients used in one season while the next season's crop uses different nutrients.

The principal advantage of Cruse's technique is that it promotes diversity, the biggest need in Iowa's agriculture, he said. Diversity protects the farmer by spreading economic risks over more than

Increased efficiency is the name of the game in modern crop production, but must be balanced with concern for the environment.. Strip intercropping answers both questions by reducing inputs and increasing yields.

one crop. Diversity comes from changing the location of the crops from year to year, from spacing the crops in a field and by growing more than one crop.

By encouraging farmers to put their eggs in more than one basket, strip intercropping provides economic benefits for the farmers in the form of increased yields. "If you plant corn after something other than corn, you have a higher yield than if you plant corn after corn," Cruse says. "We know that--that's not new at all. And the same thing holds for soybeans."

Soybeans have the ability to store nitrogen in their root systems. After the harvest the roots remain in the ground, leaving nitrogen for the next season.

Because farm implements work a fixed, with a four-row width being a typical minimum number of rows, a farmer would plant the narrowest strips that the machine allowed.

Farm equipment forces a compromise with a gardener's method of planting a single row of a crop. Because farm implements work a fixed number of rows, with a four-row width being a typical number of rows, a farmer would plant the narrowest strips the machine allowed.

The benefits of strip intercropping can be dramatic. Cruse says that some of his test crops of corn have increased yields by 50 bushels per acre, an increase of almost one-third compared to a statewide average yield of about 140 bushels per acre. But these figures are not the whole story.

"Corn converts energy from the sun very efficiently," Cruse says. "Soybeans do not use sunlight as efficiently. Because soybean plants are shorter than corn plants, the two rows of corn on the outside of the strip of corn are exposed to more sunlight than if they were in the middle of a whole field of corn and will produce higher yields."

It is these outside rows which have shown the 50-bushel increase in production, but any increases have to be averaged out over the entire strip of corn. Still, if the farmer uses a four-row strip, then the total increase in corn yield would be 25 bushels per acre. Cruse says that an additional 50 bushels per acre was an exceptional yield, and that an increase of 20 to 30 bushels per acre would be more typical.

The corn plants shade the edges of the strip of soybeans, but Cruse says that the loss of yield in soybeans is less than the gain in corn production.

In addition, the farmer enjoys the

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rotational benefit from planting corn where soybeans grew the year before. "If we have a rotation benefit for corn of 12 to 15 bushels per acre and you throw in the eight or ten bushel per acre increase because of the strip effect, we have a total benefit of 20 bushels per acre," Cruse says. "And that's pretty conservative; if I were to bet, I would say we're closer to 30 bushels than 20, year in and year out."

Cruse is also pioneering research to including a third crop into the strip rotation, one that would help control soil erosion. Because small-grain plants grow closely together, a field of small grain such as wheat, oats or barley protects the soil from being washed or blown away.

Cruse wants to determine whether the small-grain crop can be used in a strip intercropping method without affecting the profitability of the two-crop method. "The thing that's new, that we can't find any information on, is what happens when you incorporate small grain strips with the corn and soybeans," Cruse says.

The research so far has used oats as the third crop. Oats, like the soybeans used in strip intercropping, do not use sunlight efficiently, so Cruse was expecting a decrease in yield similar to the drop in soybean production. "But what we're finding is that the oat yields seem to be increasing," Cruse says. "They tend to be higher in the strip configuration than in single-crop fields."

Anyone who is concerned about the environment could breathe more easily if this cropping system ever finds widespread acceptance because the crop yields go up despite reduction in the use of herbicides, pesticides and nitrogen fertilizers, according to the results from Cruse's research, which began in 1986.

"It takes the equivalent of about one gallon of diesel fuel to produce only about four pounds of nitrogen."

Strip intercropping provides two means of reducing the amount of nitrogen that would be applied. In addition to the rotational benefit, farmers can plant a bean crop in the strips cleared of the small grain after harvesting in mid-July and use the remainder of the growing season to provide nitrogen for the next season.

Cruse is attempting to find a crop suitable for the short growing season. "We're selecting crops that show rapid, early growth. Since the legume won't be mature enough to harvest and the plant will be left in the field, we are selecting more for nitrogen benefits than for a good cash crop." Cruse says that one legume being considered is the peanut plant.

By using such a cropping rotation, Cruse says, farmers should be able to reduce the amount of nitrogen normally applied to the corn crop by about 30 percent.

"The reason I think that is very critical is that nitrogen is very energy-expensive. It takes the equivalent of about one gallon of diesel fuel to produce only about four pounds of nitrogen," Cruse says. Strip intercropping should provide between 40 and 50 pounds of nitrogen per acre.

There are important health benefits from reducing the amount of nitrogen applied to fields. Nitrates, a form of nitrogen, wash into the groundwater and contaminate drinking water. Nitrates are thought to cause cancer and a blood disorder in infants. Although nitrogen is supplied by legumes and might still turn up as ni-

trates in water, it is much less likely to contaminate water supplies than chemical nitrogen fertilizers.

Strip intercropping rotation may also reduce the demand for other chemicals, Cruse says. "You remove much of the need for insecticides--at least we think we can--with this system," Cruse adds. "A pure rotation would break any insect/pest cycle. With the strip concept, along the edges of strips just a few inches separates the position of this year's crop from last year's position."

Also, because the crops are just two strips apart, a pest infestation in one strip might spread to other strips.

"We don't know yet what the potential for pest migration might be, but it should be lower than in bulk fields," Cruse says.

Similarly, the need for herbicides is reduced because of the rotation of crops. "Farmers will have to take more care in how the herbicides are applied, since a herbicide targeted for one weed might be toxic to the crop in the next strip," Cruse says. But such caution in applying herbicides is the way they were originally intended to be used.

Cruse's use of small grains addresses environmental concerns about topsoil erosion. Use of other methods to control erosion, such as planting strips of grass or alfalfa next to streams, will help control some of the erosion, but Cruse says that most of the damage has already been done after the runoff leaves the field. "With the meadow crops such as oats or alfalfa in strips in the field, you now have erosion protection where erosion would actually take place," Cruse says.

Planting a legume after the grain harvest provides an additional six to eight weeks of erosion protection.

Although strip intercropping has the potential to offer solution to a number of Iowa's environmental and agricultural concerns, Curse says he believes that acceptance by the average farmer is some time away. "One factor that will come into play is that the system is a little more management-intensive than the conventional systems," Cruse says. "This system works best with tillage systems that take time to learn--it's a management commitment."

"Farmers wil have to take more care in how the herbicides are applied, since a herbicide targeted for one weed might be toxic to the crop in the next strip."

Other factors that might slow strip intercropping's acceptance are the farmer's need for compatible implements for the new growing system, the low market price for oats and the method the federal government uses to determine farm subsidy payments.

Cruse says that in Iowa these payments are based on the number of acres of corn grown each year. If some acres are switched for soybeans or oats, subsidies would go down for the farmer.

But that hasn't stopped some Iowa farmers from pursuing the system on their own.

Tom Frantzen, a farmer who lives near New Hampton, planted 40 of his 320 acres in a strip intercropping system last year. His results were so promising that he will be planting more acreage in strips this season.

"I saw an increase of 36 bushels an acre in corn yields, eight to 10 bushels in oats, and we didn't lose any yield in soybean production," Frantzen says. The year before, Frantzen's yields had produced 130 bushels an acre of corn, and about 100 bushels of oats an acre. Soybean production was 44 bushels per acre.

Frantzen says that he didn't need any extra time to manage his crops during the growing season. "It did take a little extra time in the winter, but there wasn't any change once the season started."

Frantzen uses four-row strips and estimates that a maximum of 400 acres could be farmed in a four-row intercropping system. "You could use strip intercropping on a larger operation, but you would need larger equipment, which reduces the benefits of the exposed rows of corn," Frantzen says.

Frantzen is one of the directors of Practical Farmers of Iowa, a group that encourages the use of sustainable agricultural methods. "Strip intercropping is part of a trend in agriculture toward more labor-intensive, and less capital-intensive, farming methods," Frantzen says.

"And that's what we really hope to see," Cruse says. "We can't change the entire agricultural system overnight, and maybe we're too far away yet. But if we can get enough Iowans interested, we just might be able to start solving some of the problems we've created."

Undergraduate Clubs

Ag Business Club–Open to all agriculture majors but especially of interest to ag business majors. The club sponsors Ag Career Days and regular meetings feature guest speakers. Contact Paul Doak or Ron Deiter/294-5436.

Ag Education Club–Professional leadership development organization to promote individual and group decision-making and cooperation among agricultural educators. Contact Robert Martin/294-0896.

Ag Engineering Club–The ISU student branch is part of the American Society of Agricultural Engineers and promotes professionalism in ag engineering. Contact Carl Bern/294-1270 or Morton Boyd/294-2874.

Ag Mechanization Club–Promotes an increased understanding of agricultural mechanization, leadership opportunities and fellowship among members. Contact Victor Bekkum/294-5145 or Duane Mangold/294-5025.

Ag Communicators of Tomorrow (ACT)–Stimulates interest in profession and facilitates the exchange of ideas among students, faculty and professionals. Contact Veryl Fritz/294-0486.

Agronomy Club–Promotes education and fellowship among students, faculty and other interested persons through trips, socials and speakers. Contact Russ Mullen/294-3271 or Tom Loynachan/294-3064.

Alpha Zeta–An honorary club dedicated to scholarship, character and leadership in agriculture. Contact Donald Woolley/294-3066, Leo Timms/294-4522 or Richard Carter/294-0895.

Block and Bridle–By using professional procedures, the club organizes and coordinates activities that provide students the opportunity to practice leadership abilities. Contact Gene Rouse/294-5641 or Dan Morrical/294-2240.

Dairy Science Club–Promotes fellowship and leadership among students interested in the dairy industry. Contact M.D. Kenealy or Bill Wunder/294-6021.

Entomology Club–Gives interested students an opportunity to interact with one another on a personal and/or academic level. Contact Wayne Rowley/294-1573.

Farm Operation Club–Broadens the views and develops leadership skills of students interested in agriculture by promoting new ideas through speakers, programs and special activities. Contact Tom Bass or asst. advisor Michele Rummens/294-6924.

Fisheries and Wildlife Biology Club/Student Chapter of the Wildlife Society–Encourages concern for and understanding of wildlife resources; provides for interaction among interested students. Contact Jim Pease/294-7429.

Food Technology Club–Promotes interest in the food industry and provides educational, social and recreational activities to its members. Contact Zivko Nikolov/294-3157 or Deland Myers/294-5216.

Forestry Club–Creates social interaction among students and develops professional interest in modern forestry topics. Contact Joe Colletti/294-4912.

Horticulture Club–People with a common interest in plants who gather in a social atmosphere to participate in educational activities related to horticulture. Contact Nancy Agnew/294-0038 or Nick Christians/294-0036.

International Agricultural Club–Open to international ag majors and others interested. Contact Harold Crawford/294-8454.

National Agri-Marketing Association (NAMA/ISU)–Provides opportunities to contact professionals, discover internship opportunities, explore careers and gain marketable experience. Contact Veryl Fritz/294-0486.

Public Service and Administration–Exists to promote information on careers and opportunities in PSA as it relates to agriculture and rural areas. Contact Eric Hoiberg/294-1922.

Society of American Foresters, ISU Student Chapter–Promotes professional involvement through attendance at state and national meetings of the society and with on-campus speakers and projects. Contact Richard Schultz/294-7602.

Soil Conservation Society of America, ISU Student Chapter–Addresses current issues in the wise use of our natural resources and provides programming on related topics. Contact Rick Cruse/294-7850.

Sigma Alpha–Provides opportunity for women to share career and academic interests relating to agricultural fields. Contact Suzanne Klocke/294-0048.

Graduate Clubs

Agronomy Graduate Student Club–Professional and social activities encourage cooperation, information exchange and good human relations among interested individuals. Contact Al Blackmer/294-7284 or Rick Cruse/294-7850.

Entomology Graduate Student Organization–Formally voices student interests and concerns, promotes professional and educational enhancement and is a peer information source. Contact Jon J. Tollefson/294-8044.

Forestry Graduate Student Association–Sponsors forestry graduate student/faculty social and professional functions; represents department graduate students in faculty meetings. Contact Carl W. Mize/294-1456.

Genetics Graduate Student Organization–Affords graduate students a collective forum for discussion of new developments and issues in genetics. Contact Alan G. Atherly/294-7133.

Graduate Organization in Agricultural Education (GO in AG ED)–Fosters an atmosphere for personal and professional development of agricultural education graduate students at ISU. Contact Alan Kahler/294-0894.

Meat Science Club-Stimulates interest and promotes academic excellence in meat science. Open to any interested graduate student. Contact D.G. Olson/294-1055.

Graduate Animal Nutrition Club (GANC)–Provides opportunities for and encourages interaction among graduate students and faculty in animal science studying nutrition. Also provides resources for a nutrition reading room in animal science to support quality academic learning. Contact Dean Zimmerman/294-2133.

Front row: Brian Fischer, Marty Taglauer, Pat Ries, Tim Harbaugh, Pat Von Tersch, Andrew McPherson, Brady Sutton. **Second row:**Tina Geffert, Jill Schwalbe, Kari Neumann, Bonnie Cowell, Tom Johnson, Matt Musselman, Ron Deiter, Alissa Peitscher. **Third row:** Tina Hoser, Janet Figland, Martha Hellman, Marcia Hopkins, Brenda Steinkamp, Joanne Grady, Kelly Ulrick. **Fourth row:**Julie Tritz, Margaret Herrog, Marla Clark, Brad Lehmann, Kevin Eblen, Anthony Brown, Ron Moen. **Fifth row:** Rodger Main, Steve Decook, John Fish, Jeff Grant, John McMillan, Todd Wiley, Jim Gibson, Jeff Fox.

AG COUNCIL
Unifying the Ag College

Representing student clubs in the College of Agriculture, the Iowa State University Agricultural Council coordinates college activities and participates in college planning. Students on the Council participate in outreach trips promoting the College of Agriculture and agricultural professions.

The council has a voice on all-university academic advising, scholarship and curriculum committies.

For more information regarding the Ag Council activities and opportunities, contact your club's representative.